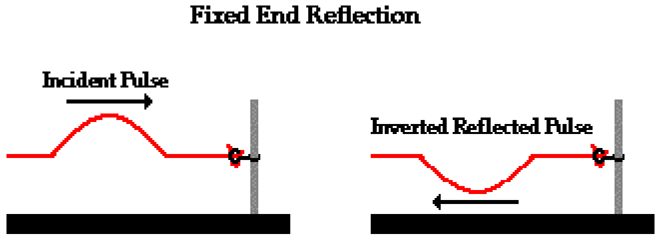
Behavior of Waves

Boundary Behavior

As a wave travels through a medium, it will often reach the end of the medium and encounter an obstacle or perhaps another medium through which it could travel.

Fixed End Reflection

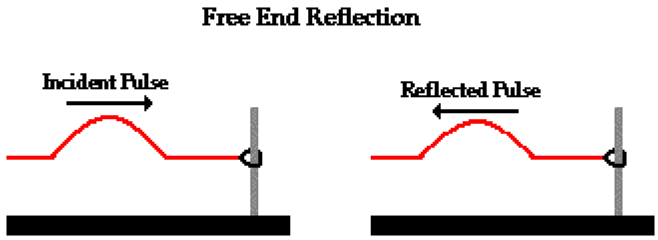


The inversion of the reflected pulse can be explained by returning to our conceptions of the nature of a mechanical wave. When a crest reaches the end of a medium ("medium A"), the last particle of the medium A receives an upward displacement. This particle is attached to the first particle of the other medium ("medium B") on the other side of the boundary. As the last particle of medium A pulls upwards on the first particle of medium B, the first particle of medium B pulls downwards on the last particle of medium A. This is merely Newton's third law of action-reaction.

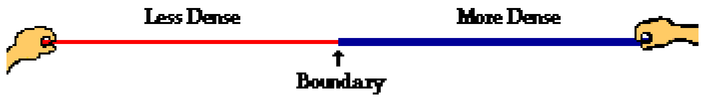
- The speed of the reflected pulse is the same as the speed of the incident pulse.
- The wavelength of the reflected pulse is the same as the wavelength of the incident pulse.
- The amplitude of the reflected pulse is less than the amplitude of the incident pulse.

Of course, it is not surprising that the speed of the incident and reflected pulse are identical since the two pulses are traveling in the same medium. Since the speed of a wave (or pulse) is dependent upon the medium through which it travels, two pulses in the same medium will have the same speed.

Free End Reflection



Transmission of a Pulse Across a Boundary from Less to More Dense

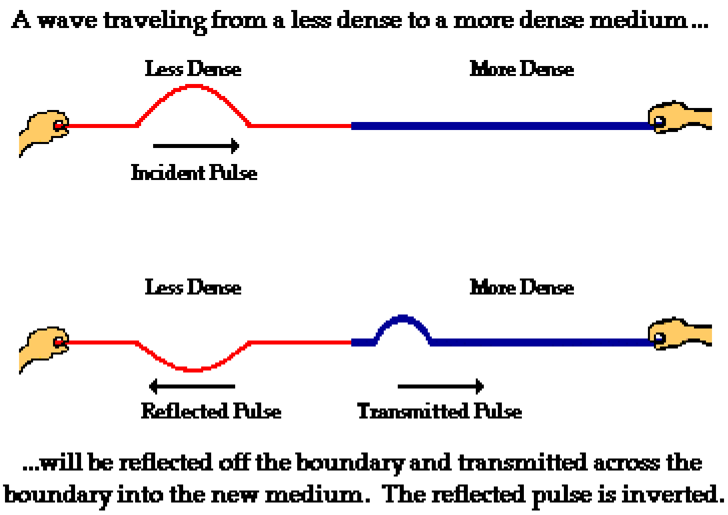


Upon reaching the boundary, the usual two behaviors will occur.

A portion of the energy carried by the incident pulse is reflected and returns towards the left end of the thin rope. The disturbance which returns to the left after bouncing off the boundary is known as the reflected pulse.

A portion of the energy carried by the incident pulse is transmitted into the thick rope. The disturbance which continues moving to the right is known as the transmitted pulse.

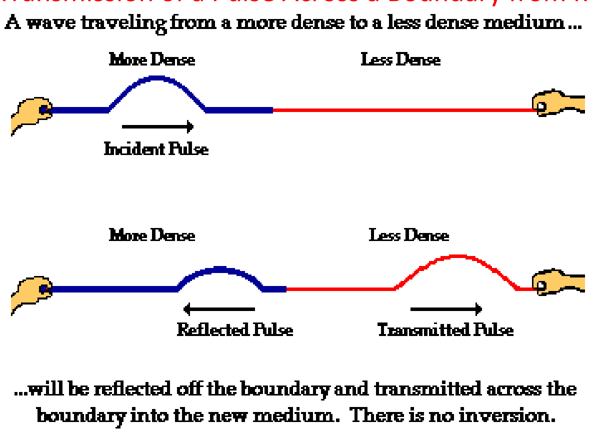
The reflected pulse will be found to be inverted in situations such as this.



Comparisons can also be made between the characteristics of the transmitted pulse and those of the reflected pulse. Once more there are several noteworthy characteristics.

- The transmitted pulse (in the more dense medium) is traveling slower than the reflected pulse (in the less dense medium).
- The transmitted pulse (in the more dense medium) has a smaller wavelength than the reflected pulse (in the less dense medium).
- The speed and the wavelength of the reflected pulse are the same as the speed and the wavelength of the incident pulse.

Transmission of a Pulse Across a Boundary from More to Less Dense



Comparisons between the characteristics of the transmitted pulse and the reflected pulse lead to the following observations.

- The transmitted pulse (in the less dense medium) is traveling faster than the reflected pulse (in the more dense medium).
- The transmitted pulse (in the less dense medium) has a larger wavelength than the reflected pulse (in the more dense medium).
- The speed and the wavelength of the reflected pulse are the same as the speed and the wavelength of the incident pulse.

The boundary behavior of waves in ropes can be summarized by the following principles:

- The wave speed is always greatest in the least dense rope.
- The wavelength is always greatest in the least dense rope.
- The frequency of a wave is not altered by crossing a boundary.
- The reflected pulse becomes inverted when a wave in a less dense rope is heading towards a boundary with a more dense rope.
- The amplitude of the incident pulse is always greater than the amplitude of the reflected pulse.